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THE EFFECTS OF POLLUTION CONTROL ON THE NONFERROUS METALS INDUSTRIES

ZINC

Part I

Introduction and Executive Summary

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CHARLES RIVER ASSOCIATES INCORPORATED · CAMBRIDGE, MASSACHUSETTS

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THE ECONOMIC EFFECTS OF POLLUTION CONTROLS ON THE NONFERROUS METALS INDUSTRY: ZINC

Prepared for
the Council on Environmental Quality

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PREFACE

This report on the economic effects of pollution controls on the zinc industry has been organized into three parts comprised of eight chapters. The three parts can be read separately or in conjunction with one another. Part I summarizes the contents of the succeeding two parts, providing a broad profile of the zinc industry and outlining the economic effects of pollution controls on the industry. The important points and conclusions of the full report are contained in the first part, with greater detail and analysis in the following two parts.

Part II comprises separate chapters on:

Trends in supply and the technology of production
Consumption
Structure of the industry
Prices
Government policies
The zinc industry in the United States

Part III is our detailed analysis of the economic effects of imposing pollution controls on the zinc industry.

Much of the information contained here was first published in Charles River Associates Incorporated, *An Economic Analysis of the Lead-Zinc Industry* (Cambridge, Mass., 1967, rivised 1969), which we prepared under contract with the General Services Administration. Data presented in this report if not otherwise attributed is taken from our GSA report.

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PART I

Chapter 1
INTRODUCTION AND EXECUTIVE SUMMARY

Overview of the Zinc Market

The zinc market has shown moderate growth over the past two decades, with more rapid growth outside the United States than within. World consumption rose in the 1950's by about 3 percent annually, then accelerated through the first half of the 1960's to about a 6 percent annual rate, and has tapered off somewhat, with annual fluctuations, since 1965. As in the case of lead, Europe's consumption of lead and zinc was in traditional uses until quite recently, when it began extensive use of the metals in the automotive and appliance technologies developed earlier in the United States. Japan's rapid postwar growth has also created large markets for the more modern uses of zinc.

Zinc is used predominantly as an input in the production of other commodities. The major consumers of zinc

are the die casting shops whose products are parts for the automotive, home appliance and office machine industry, the steel industry for galvanized protective coatings, and the brass mills for various alloys with copper. Of these markets, die casting is the main source of growth. This is also the use of zinc most vulnerable to displacement by substitute materials, particularly injection-molded plastics and aluminum. The future growth rate of zinc consumption will depand importantly upon the extent of such substitution. Die casting accounted for 37 percent of 1970 U.S. consumption, while galvanizing and brass contributed 24 and 14 percent, respectively.

Technology of Production

Zinc occurs in ores which vary considerably in zinc content. The most common mineral is zinc sulfide, or sphalerite. In the eastern United States the mineral is high in zinc content, with lead being a by-product. In the central states a higher lead content is common, and in the western states several elements are generally found in coproduct proportions.

There are four stages in the transformation of zinc ore into commercial form: mining, milling, smelting, and refining. Mining and milling take place in close proximity, whereas the trend for smelting and refining is to locate near production centers. Slab zinc and zinc oxide are the major product forms of this production sequence. The major ore producing countries are Canada (1,211,000 short tons in 1970), the United States (547,000 short tons), Australia (408,100 short tons), Peru (337,000 short tons),

Mexico (294,000 short tons), and Japan (308,000 short tons). Total noncommunist ore production in 1970 was 4,343,000 short tons (zinc content).

Zinc mines give rise to relatively minor environmental problems. Not much land surface area is required, and mine locations are generally remote. Most mine wastes are either commercially utilized or returned to the mine. Dust emission is relatively easily controlled.

The level of costs varies considerably among individual mining and milling establishments, but the behavior of unit costs can be represented in a general fashion. The typical mining company has a large proportion of fixed costs (approximately one-fifth of total costs), and roughly constant average costs both for moderate changes in intermediate term output and for substantial changes in long-run output.

Some concentrates produced at the mills are made into zinc oxide, but most are subjected to further treatment for recovery of zinc metal in slab form. Concentrates are roasted to drive off the sulfur as sulfur dioxide and to obtain oxidized zinc. The reduction and recovery of zinc is then achieved by one of a variety of metallurgical processes. The horizontal retort process is the oldest and most costly, and is being replaced world wide by newer methods. The vertical retort and electrolytic processes are more efficient, each being better suited for specific concentrate types and purity grades of output. A fourth process, the Imperial Smelting Process, is suitable only for specific types of lead-zinc ores.

Almost all zinc ore is converted into slab zinc. The major zinc smelting countries are the United States

(887,000 short tons of slab zinc production in 1970), Japan (745,000 short tons), Canada (461,000 short tons), West Germany (332,000 short tons), Australia (287,000 short tons, and France (247,000 short tons). Total non-communist production of slab zinc in 1970 was 4,339,000 short tons.

The major waste problem is the emission of sulfur dioxide, which occurs in the roasting and sintering stages of the smelting process for retort methods of reduction and in the roasting stage for electrolytic methods. Other dust and gaseous emissions are relatively easily controlled, except for particulate zinc oxide emissions from horizontal retorts. The sulfur dioxide may also be captured relatively easily from a technological point of view by means of an acid plant which produces sulfuric acid. However, the sulfur concentration of the off-gases can be quite low, which results in high recovery costs.

Smelting and refining costs may account for approximately one-half of total zinc mining and refining costs, the other half accounted for by the acquisition of zinc concentrates. As the electrolytic process is more capital intensive than the retort distillation processes, its fixed costs are a larger proportion of total costs. This proportion may be about 30 percent for electrolytic plants and about 10 percent for distillation plants. For the long run, smelter costs per unit are probably nearly constant for large scale output.

Mine production of zinc is expected to grow in Canada, Mexico, Australia and Peru, but appears to be stagnant within the United States. These major foreign producers

plus Japan and several European countries are expected to expand their smelter production, which is declining in the United States.

Consumption of Zinc

Zinc is used predominantly as an input in the production of other commodities. The major use categories for zinc are galvanizing (protective coating for other metals), die casting (machine parts made by forcing molten metal into molds) and copper base alloys (primarily to produce brass). It is also used in rubber, paints, ceramics, and a variety of chemical products.

Domestic Zinc Consumption Classified by End Use

(Thousands of Short Tons and as a Percentage of U.S. Total)

End Use	1950	1958	1962	1969
Galvanizing	338.1 (29.5)	321.1 (30.9)	307.3 (26.7)	375.9 (24.1)
Die Casting	288.6 (25.2)	310.5 (29.9)	418.4 (36.7)	573.1 (36.7)
Copper Base Alloys	163.9 (14.3)	167.8 (16.2)	114.9 (10.1)	213.5 (13.7)
Other	346.1 (30.2)	281.1 (27.1)	257.9 (22.6)	399.5 (25.6)
TOTAL	1146.6	1038.1	1140.3	1562.0

SOURCE: 1969 CRA Lead-Zinc Report and ABMS *Yearbook*, 1970. The CRA report, pp. 29-30, describes the derivation of these figures, which include both slab zinc and other forms of elemental zinc.

Consumption of zinc has grown at about a 1.7 percent average annual compound rate from 1950 to 1969. The strongest component has been the zinc die casting market, whose growth rate averaged 3.6 percent over the same period. These rates have been pulled down to some extent by what might be regarded as abnormal circumstances over the past five years. The future growth rate of zinc consumption is likely to be about 4 percent per annum. If competitive intrusions on the die casting market from substitute materials halt that sector's growth completely -- which is an unlikely event -- the growth rate of zinc consumption might be reduced to 2 percent per year.

The substitute materials threatening zinc die castings are injection-molded plastics and aluminum, especially the former. Automotive parts constitute the main end use category in die casting, with office machines and home appliances contributing important shares. In combination the three account for more than 75 percent of total zinc die casting. At given prices of zinc, injection-molded plastics have been able to capture important segments of the die casting market, both by achieving technological breakthroughs and by reducing costs. These competitive intrusions are based on relatively long-term research and development efforts, so that in the short or intermediate term there is no significant direct effect of price on zinc consumption in die casting. Because of this past experience, the zinc industry is justifiably concerned that a rise in the price of zinc relative to the price of plastics might induce further substitution.

The nature of the response of substitute materials to an increase in other end uses is similar to that in die

casting, although such response is evidently weaker in the other uses.

As in the case of lead, foreign zinc consumption growth has been more rapid than in the United States, and its pattern has been different. European consumption of slab zinc grew at about a 4.3 percent average annual compound rate from 1957 to 1969, that of Japan was nearly 14 percent, while for the total noncommunist world, slab zinc consumption averaged a 6.2 percent growth rate. There has been relatively greater emphasis on brass in Europe, and on galvanizing in Japan. Greater detail on end use patterns in the United States and the rest of the noncommunist world is contained in Chapter 3 of this report.

Prices in the Zinc Industry

The benchmark quote for domestic zinc prices is the producers' quoted price for prime western slab zinc, the grade used in galvanizing. Zinc is often sold at a discount below the producers' published price, but rarely at a premium. Adherence to the published price is generally stronger than in the case of lead, however. Concentrate prices tend to be closely associated with prime western quotes.

Until 1965 the price basis for foreign sales of zinc was the LME price. Since then zinc sales abroad have been made on the basis of a price set by producers under the leadership of the Imperial Smelting Corporation of Great Britain. This price has been changed infrequently and since its inception both the LME and the U.S. producers' price have fluctuated less than before. The U.S. price tends to be above the LME price by no more than tariff and transport costs.

The behavior of zinc prices is suggestive of a concentrated market, especially so for foreign production. European price changes have appeared to be initiated by a well recognized leader, and adherence to the quoted price appears to be the rule.

The existence of relatively more successful cooperation among foreign producers, together with the greater share of zinc imports in total U.S. supply, has left less room for price discretion among U.S. producers than in the case of lead. Nonetheless, the price history of zinc is consistent with the hypothesis that there is a fairly stable mark-up between an efficient producer's long-run average costs and price. This mark-up is in the nature of an administered price with a strong element of price leadership, particularly by the lower-cost producers, which takes into account the behavior of foreign prices.

The stable mark-up between average cost and price is likely to persist in the future. Long-run average cost of the efficient producers has remained fairly constant. Under normal market conditions, the price of zinc over the next 5 to 10 years will probably be in the range of $0.16 to $0.17 per pound (in 1970 dollars), or approximately equal to the average historical (deflated) value since the Korean War.

Structure of the Zinc Industry

Zinc is marketed both as a concentrate and as smelted slab or oxide. Because a substantial portion of the world's concentrate production is carried on by integrated firms and does not reach the market, our discussion of price and output focuses on the market for slab zinc.

For some purposes it is important to distinguish between primary and secondary zinc products. Of the 1970 total supply of zinc metal in the U.S., primary producers accounted for about 58 percent and secondary producers contributed about 18 percent, with imports and stocks accounting for the remainder. Suppliers of secondary products differ from suppliers of primary products with respect to production costs, raw materials sources, entry conditions, scale of operations and concentration. The main cost to secondary producers is the price of scrap zinc. New scrap zinc is generated by consumers of slab zinc who make galvanized steel, die castings, brass, and other zinc products; old scrap is reclaimed from discarded zinc products. New scrap accounts for about 80 percent of total scrap supply, and die castings and brass account for the bulk of new scrap.

Entry into the secondary market is easier than into the primary market, as access to secondary raw materials (scrap zinc) is much easier than access to primary raw materials (mined zinc), and the time horizon for entry or capacity adjustment is shorter for the secondary than for the primary sector. The secondary zinc market is much less concentrated than is the primary sector, and the scale of operations of a secondary producer is typically very small relative to that of a primary producer. Of all domestic distilled and electrolytic zinc, primary refineries account for about 93 percent. The share of secondary producers in U.S. consumption of zinc has remained roughly constant over the past decade. As the supply of secondary zinc is closely tied to past consumption, it is insensitive to the price of zinc except perhaps in the short run.

COMPOSITION AND DISPOSITION OF
U.S. SUPPLY OF ZINC, 1970
(Thousands of Short Tons)

Components of U.S. Supply (and % of Total)		Disposition of Supply (and % of Total)	
U.S. Primary Production	1059.8 (57.9%)	U.S. Consumption	1643.9 (89.8%)
Imports of Metal	270.4 (14.8%)	Industry Stocks	187.9 (10.2%)
Secondary Metal	332.4 (18.1%)	Exports	0.29 (neg.)
Industry Stocks	168.2 (9.2%)		

After primary and secondary production, imports are the third largest contributor to domestic supply, accounting for 14.8 percent in 1970. The share of imports in total U.S. consumption has risen from less than 10 percent to about 23 percent over the 1960-1969 period, and is likely to increase still further. It appears that the decline of U.S. smelting capacity relative to consumption is contributing most importantly to this import displacement. The major exporters of zinc to the United States are Canada, Australia, Mexico, Peru and Japan.

Although there seem to be substantial international competitive pressures, national market structures vary. In France, for example, the industry structure is highly concentrated. Competitive forces in the United States appear to be stronger, although the market is becoming increasingly concentrated. The geographic scope for competition in zinc lies somewhere between the two extremes of a

national market subject to peripheral import competition and a cohesive world market where economic and political barriers are negligible.

The U.S. zinc industry contains both integrated and nonintegrated producers, with the latter including independent mining firms and custom smelters and refiners. The integrated firms own mines and mills as well as smelting and refining plants. A much larger part of their zinc output is refined from concentrates produced by their own mines and mills. Custom smelters purchase concentrates from other foreign or domestic companies and either smelt or refine or both. The distinction between custom refiners and independent producers is not absolute, as some custom refiners own mines and integrated firms do some custom work.

Refining is a more concentrated activity than is mining, both in the United States and abroad. In 1966, 10 integrated domestic producers accounted for about 98 percent of total U.S. primary and secondary zinc, and for about 55 percent of total U.S. output of mined zinc. In the noncommunist world, the primary capacity of 32 integrated primary producers accounted for 90 percent of world production. In world mining, integrated primary producers contributed at least 15 percent of mine production. Secondary zinc involves a much lower degree of integration than does the primary sector. The U.S. industry is now even more concentrated, as seven firms, most of whom do some custom work, account for all domestic primary zinc.

An indicator of the degree of concentration is world concentration in primary zinc refinery capacity. In

our 1969 report to GSA, we indicated that the top four firms' refining capacity accounted for 23 percent of the total noncommunist world production. The top eight firms accounted for nearly 40 percent, and the top 20 firms for nearly 72 percent. Domestically, the top four firms accounted for 62 percent of the value of shipments of refined zinc, and the top eight firms accounted for about 96 percent in 1963. It appears that the U.S. industry is becoming increasingly concentrated, and that foreign producers will increase their share of the domestic market at the expense of domestic production. Both of these trends are attributable to the decline of relatively high-cost mines and smelters in the United States and the expansion of mines and smelters abroad.

Government Policies in the Zinc Industry

The most important government policies currently affecting the zinc market are the import tariff and surcharge and the stockpile.

The current zinc price is $0.17 per pound. The pre-August 1971 tariff plus 10 percent of the October LME price of $0.149 exceeds the 1930 statutory tariff rate of $0.0175 per pound, so that the rate now applying to zinc imports is $0.0175 per pound. When freight and delivery charges are added, this makes the delivered price of imported zinc about $0.179 per pound.

In October 1971, GSA declared that 536,000 tons of zinc were held in excess of the stockpile target level. In that same month, letters of agreement were signed by all U.S. primary zinc producers and GSA. These agreements provided for annual producer purchases from the stockpile of up to 50,000 tons of zinc. The purchase period will stretch over about 10 years, with amounts allocated to individual smelters according to their 1970 production. The allocations are subject to review every three years. The disposal rate may be altered or suspended in times of market surplus, as measured by the ratio of primary smelter stocks to the previous year's domestic primary shipments. The metal will be priced at published quotations with individually negotiated discounts to cover reworking, handling, and distribution costs. Both the GSA and industry officials expect to complete their arrangements in time for Congress to authorize sales in 1972.

The Zinc Industry in the United States

There are three zinc mining areas in the United States, distinguished by the local ore type, which are classified on the basis of recoverable metal contained: zinc ores, lead-zinc ores, lead ores, and all other ores from which zinc is obtained. In the eastern states, ores are primarily

in the zinc category. Ores in the central states are of the lead type, and in the western states lead-zinc and more complex composite ores predominate. The major mining states are Tennessee, New York, Missouri, and Colorado. The relative importance of the first three of these is likely to increase. Ores from domestic mines provided domestic smelters with about 50 percent of 1970 requirements -- the remainder being imported.

PRODUCTION OF SOME LARGE U.S. ZINC MINERS
(Short Tons)

Company	1969
American Zinc Company	74,699
ASARCO	21,240
Bunker Hill	33,921
Eagle Picher	32,068
New Jersey Zinc	154,134
St. Joe Minerals Corporation	79,059
U.S. Smelting Refining and Mining	23,333

There are seven primary zinc reduction companies producing all of domestic primary smelted and refined zinc. These companies operate eight smelters. The smelter at Great Falls, Montana, is scheduled to shut down in mid-1972.

The eight domestic primary smelters, soon to be seven, can be categorized according to low and high production costs. The important factors determining a smelter's placement in the low-cost category are access to low-cost ores, access to good water transportation, and relatively

modern technology. The two Pennsylvania smelters and the Texas electrolytic plant share these advantages. The Idaho plant is probably in a somewhat higher cost position owing to the nature of its ore sources. The three horizontal retort plants share to some extent both the high-cost concentrate and the old technology problems. The Montana plant is scheduled to close down because of its inability to compete for concentrates.

The Economic Effects of Pollution Control on the Zinc Market

The Environmental Protection Agency has proposed standards governing both the emission into the air of sulfur dioxide from zinc smelters and the discharge of wastes into water sources. In addition, the EPA has estimated the costs of installing control equipment to meet these standards.

Pollution Control Costs

Table 8-1, from Chapter 8 of this report,[1] presents EPA data provided by the Council on Environmental Quality showing costs that would have to be incurred by zinc smelters to attain the standard of 90 percent removal of feed sulfur. Table 8-2 presents data for water pollution control costs Table 8-3 presents the combined annual costs estimated for 1976. These can be regarded as the level of costs persisting in the long run after full installation of the required pollution abatement equipment and all the costs which will affect the producers' profit rates.

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[1]Tables 8-1, 8-2, and 8-3 are reproduced here for convenience.

Table 8-1

COSTS OF CONTROLLING SULFUR DIOXIDE EMISSIONS
AT PRIMARY ZINC SMELTERS, RELATIVE TO THE STANDARD
OF 90 PERCENT REMOVAL OF FEED SULFUR
(Millions of August 1971 Dollars)

Investment Outlays

	1972	1973	1974	1975	1976
Cost to control existing facilities	2.04	4.07	14.24	16.28	4.07
Costs to control new facilities	3.44	3.44	3.44	3.44	3.44
TOTAL	5.48	7.51	17.68	19.72	7.51

Annual Costs

Operation and Maintenance	.82	2.45	8.17	14.70	16.33
Interest	.29	.87	2.80	5.20	5.79
Depreciation	.20	.61	2.03	3.64	4.05
TOTAL	1.31	3.93	13.00	23.54	26.17

"Total" Costs

Total Cash Costs[1]	6.59	10.83	28.65	39.62	29.63
Total Direct Costs[2]	6.30	9.96	25.85	34.42	23.84

[1]Investment costs plus annual costs minus depreciation.

[2]Total cash costs minus interest.

SOURCE: Council on Environmental Quality

Assumptions: 1) Because of the weak sulfur dioxide concentration of the off-gas streams of roasters and sinter machines, the proposed control method incorporates the upgrading of flues to reduce gas volumes and then limestone scrubbing to remove the sulfur dioxide.
2) The interest rate is 10 percent.
3) The growth of production is 2.2 percent per year.
4) The depreciation rate is 7 percent per year.
5) No down time for installation is envisaged.

(Table 8-1 continued on following page)

Table 8-1 (Continued)
COSTS OF CONTROLLING SULFUR DIOXIDE EMISSIONS

Assumptions: (Continued)

6) A smelter model of zero current control, producing 92,000 tons per year, and operating at full capacity for 330 days a year, was used for the cost calculation.
7) The sulfur dioxide concentration of the smelter gas is assumed to be 2 percent.
8) Six zinc smelters were assumed to require control.

Table 8-2

COSTS OF WATER POLLUTION CONTROL FOR THE LEAD AND ZINC INDUSTRY COMBINED, RELATIVE TO THE STANDARD OF EQUIVALENT OF SECONDARY TREATMENT

(Millions of August 1971 Dollars)

	1972	1973	1974	1975	1976
Investment Outlays					
Existing Facilities	1.557	1.629	1.703	1.775	1.848
New Facilities	0.231	0.235	0.240	0.245	0.250
Total	1.788	1.864	1.943	2.020	1.098
Annual Costs					
Operation & Maintenance	0.204	0.411	0.617	0.823	1.030
Interest	0.115	0.231	0.347	0.463	0.580
Depreciation	0.071	0.143	0.217	0.289	0.362
Total	0.340	0.785	1.181	1.575	1.972
"Total" Costs					
Total Cash[1]	2.107	2.506	2.907	3.306	3.703
Total Direct[2]	1.992	2.275	2.560	2.843	3.123

[1] Investment costs plus annual costs minus depreciation.
[2] Total cash costs minus interest.

SOURCE: Council on Environmental Quality

ASSUMPTIONS:
(1) Lead and Zinc smelters would apply coagulation, sedimentation, and neutralization to 100 percent of process wastewater.
(2) The interest rate is 8 percent.
(3) The growth rate of lead production is 1.4 percent and that of zinc production is 2.2 percent per year.
(4) The depreciation rate is 5 percent per year.
(5) Some downtime for installation is included.

Table 8-3

ANNUAL COSTS OF SULFUR DIOXIDE EMISSION
AND WATER POLLUTION[1] CONTROL
AT PRIMARY ZINC SMELTERS IN 1976

U.S. Production To Which CEQ Control Costs Apply (Tons)	Total Annual Abatement Cost ($ million)	Middle Estimate of Abatement Cost ($ per pound)	Low Cost[3] Estimate ($ per pound)	High Cost[3] Estimate ($ per pound)
1,004,000	27.156	0.0135	0.0123	0.0267
502,000	27.156	0.0270	0.0246	0.0534

SOURCES: Tables 8-1 and 8-2

[1]The annual costs of water pollution control are given by CEQ for the combined lead and zinc industries. The figures in this table are based on the arbitrary allocation of half that combined figure to lead and half to zinc. The results are not sensitive to this allocation, as air pollution control costs for the zinc industry are larger than combined lead and zinc industry water pollution control costs by a factor of over 13.

[2]The CEQ's estimated growth rate of zinc production -- 2.2 percent per year -- is applied arithmetically to 1970 U.S. zinc output of 887,200 tons to yield the figure of 1,004,000 for output in 1976. This is the figure applying in the case that control costs are spread evenly over the entire U.S. output. For the case in which the control costs are borne by less than half of domestic capacity, the figure of 1,004,000 is divided by two to get 502,000 tons per year, which results in a doubling of the per pound cost estimates. This is a rough estimate of the per pound cost increases which will be faced by those smelters needing pollution control.

[3]The high and low cost estimates allowed the minus 10 to plus 10) percent error for air pollution control costs, and no error for water pollution control costs.

Effects of Pollution Controls on the Zinc Industry

In the absence of pollution abatement costs, U.S. zinc consumption is likely to increase at an average annual compound rate in the neighborhood of 4.0 percent. The growth would occur primarily in the die casting market, which appears likely to hold its own against further competitive intrusions by substitute materials. Neither the total consumption trend nor that of die casting is likely to be altered by the imposition of pollution control costs because the price changes that can be expected to follow the pollution cost increase are fairly small.

The major trends on the supply side of the zinc market are the decline of older, high-cost mines and the smelters that drew upon them for ores, an increase in market concentration, and an increase in the foreign producers' share of the slab zinc market. The important factors causing this change are the development of rich ore deposits and new, low-cost smelters abroad and the playing out of older mines and smelter technologies within the United States. These trends form an important part of the basis for our segmentation of the domestic primary zinc industry into high- and low-cost producers. The major impact of abatement costs will be to accelerate these trends.

The price of zinc is likely to remain constant or increase slightly in real terms in the absence of abatement costs, due to similar trends in production costs. The effects of abatement costs on price will depend importantly upon their incidence on high- and low-cost producers. It appears very likely that the abatement costs will fall

much more heavily upon the high-cost producers, in which case it is likely that any price increases caused by pollution controls will be moderate. In the less likely event that abatement costs fall equally upon all producers, some substantial price increase can be expected. However, the price increases will be significantly less than the cost increases, because of the pressures of foreign competition and of the fears of long-run substitution of other materials for zinc in its end uses. Any price increases will cause an acceleration of the trend towards a higher share of zinc metal imports in U.S. consumption.

In the absence of abatement costs, there will probably be a continuation of the trend toward less employment in mining and smelting. The impetus for this decline arises both from increased mechanization and automation through all stages of production and from the fact that the mining areas in Tennessee, New York, and Missouri which are likely to be the main ore source in the future are less labor intensive than the older mining operations. The effect of abatement costs will be to accelerate the decline of employment in the high-cost sector. This is likely to have more severe effects in Oklahoma and perhaps Idaho, which are more rural and undiversified, than Texas.

As the price change that can be expected to follow the pollution cost increase is moderate, it is not likely that there will be greatly increased imports on this account alone. The most severe impact would occur if all high-cost firms shut down and were replaced entirely by imports. It appears likely that the maximum amount of high-cost producer market loss is between 365,000

and 572,000 tons per year. If low-cost domestic producers expand their operations by 25 percent, there would be room for additional imports of 230,000 to 365,000 tons. (That all high-cost producers close and that the low-cost producers expand production by only 25 percent are extreme assumptions.) At the current price of $340 per ton, this would mean additional import values of $78,000,000 to $124,000,000. This increase is likely to be offset to some extent by reduced imports of concentrates and should be regarded as an extreme upper limit estimate. The net effect on the balance of payments, however, depends upon numerous changes and adjustments that may occur throughout the economy.

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